Figure 10 shows the aerosol propellant receptacle and stem valve assembly and the stem valve through hole.

Figure 11 shows a cut away view of the apparatus according to the preferred embodiment of the invention before the beverage is filled into the container, the aerosol propellant receptacle is filled with water, and the stem valve attached by a snap to a hole through the container bottom wall.

Figure 12 shows a cut away view of the apparatus according to the preferred embodiment of the invention with beverage filled into the container and surrounding the aerosol propellant receptacle walls, the aerosol propellant receptacle filled with water, and the stem valve attached by a snap to a hole through the container bottom wall.

Figure 13 shows the apparatus with the lid seamed unto the container to seal the beverage product and the aerosol propellant receptacle inside the container.

Figure 14 shows the water in the aerosol propellant receptacle being expelled by the pressure of the liquified dose aerosol propellant.

Figure 15 shows the apparatus being charged with liquified aerosol propellant.

Figure 16 shows the beverage container opening means opened to atmospheric pressure, and the aerosol propellant receptacle valve seat dislodged from the stem valve sealing cone breaking the seal for the liquified gas to escape from the aerosol propellant receptacle. The figure also shows that only the gaseous phase of the gas can escape when the container is opened.

Figure 17 shows a schematic of one embodiment of an assembly process for the apparatus, with water being poured into the aerosol propellant receptacle and the stem valve attached

to the beverage container, and then the aerosol propellant receptacle being attached to the stem valve.

Figure 18 shows the stem valve being inserted into the water filled aerosol propellant receptacle, as an example of the assembly process during which the aerosol propellant receptacle stem valve are first assembled before assembling the two with the beverage container.

Figure 19 shows the stem valve being assembled with the container bottom wall hole as an example of the assembly process during which the stem valve and the container are first assembled together before the water filled aerosol propellant receptacle is assembled with the stem valve.

Figure 20 shows a container with a valve stem attached and a rig for inserting the aerosol propellant receptacle into the valve stem.

Figure 21 shows a cut-away view of the aerosol propellant receptacle according tothe second embodiment with the aerosol propellant matrix filling the aerosol propellant receptacle for assembly with the container and stem valve assembly.

Figure 22 shows a cut-away view of the aerosol propellant receptacle according to the second embodiment with the salt crystal matrix filling the aerosol propellant receptacle for assembly with the container and stem valve assembly, and the valve seat hole for communication of the container contents with the salt crystal.

Figure 23 shows a cut-away view of the aerosol propellant receptacle according to the second embodiment with the salt crystal matrix filling the aerosol propellant receptacle

being saturated with water based container contents for achieving an endothermic reaction.

Figure 24 shows a beverage bottle preform prior to forming the bottle and the aerosol propellant receptacle.

Figure 25 shows a cross section of the bottle preform.

Figure 26 shows the first stage of blow molding a bottle shape while the aerosol propellant receptacle is still not blown.

Figure 27 shows the second stage of blow molding the aerosol propellant receptacle inside the bottle.

Figure 28 shows a cut away view of the bottle and the stem valve assembly.

Figure 29 shows an exploded view of the bottle and valve assembly in the second preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As required, detailed embodiments of the present invention are disclosed herein;however, it is to be understood that the disclosed embodiments are merely exemplary of the invention which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. In particular, whenever the words liquified aerosol propellant are used, they also refer to aerosol propellant mixtures of an activated carbon matrix or Carbon Fullerine Nanotubes with a high pressure aerosol propellant such as CO2,N2, or other suitable gases.

Reference is now made to the drawings, wherein like characteristics and features of the present invention shown in the various FIGURES are designated by the same reference numerals.

Referring to FIGURES 1 AND 3-20, a self cooling beverage container apparatus 10 is disclosed.

In the first of the preferred of several possible embodiments, the apparatus 10 includes a conventional container 100 such as a metal or plastic can containing container contents 110 having

a conventional unified domed container bottom wall 102 , and a cylindrical container side wall 101 terminating in an upper container sealing rim 103. A container sealing lid 104 is also provided for sealing off the container contents 110 inside the container 100 with container sealing rim 103. A round container bottom wall hole 108 passes through the center of the domed container bottom wall 102.

The apparatus 10 further comprises a thin walled plastic or metal aerosol propellant receptacle 20 with substantially the shape of a small plastic or metal bottle with a bottle neck. With the said aerosol propellant receptacle 20 oriented so that it sits on a bottom wall 204 and with the open end facing an upwardly direction, the aerosol propellant receptacle 20 comprises a substantially horizontal round top wall 210 from the center of which wall is joined a short smaller diameter cylindrical aerosol propellant receptacle neck protrusion 201 which terminates with a thin aerosol propellant receptacle open neck round flange 202. Said aerosol propellant receptacle open neck flange 202 having a slightly larger diameter than the cylindrical aerosol propellant receptacle open neck protrusion 201. The aerosol propellant receptacle top wall 210 has a diameter that is greater than the diameter of the aerosol propellant receptacle open neck protrusion 201. The top wall 210 and the aerosol propellant receptacle open neck protrusion 201 form a continuous unified wall of the aerosol propellant receptacle 20 with the aerosol propellant receptacle open protrusion neck 201 forming a passage through the aerosol propellant receptacle top wall 210 as an entry way for ingredients that are to be stored inside the aerosol propellant receptacle 20. A aerosol propellant receptacle side wall 200 sealingly joins the aerosol propellant receptacle top wall 210 protruding in the downward direction to sealingly join a substantially round aerosol propellant receptacle bottom wall 204. Thus, the aerosol propellant receptacle 20 walls are all joined together to form

continuous bottle with an open neck. The aerosol propellant receptacle bottom wall 204 is designed to be slightly flexible and to flex up and down the axis of the aerosol propellant receptacle 20, so as to increase the overall length of the aerosol propellant receptacle 20 when the pressure acting inside the aerosol propellant receptacle 20 walls is greater than the pressure acting outside the aerosol propellant receptacle 20 walls. In general the walls of the aerosol propellant receptacle 20 are flexible and thin relative to its size. The aerosol propellant receptacle 20 is also designed to be handled easily for manufacturing the self-cooling container so that the processes that would be encountered during the manufacturing would be easily accomplished because of the way the aerosol propellant receptacle 20 is designed and works. The aerosol propellant receptacle 20 is also designed to store a liquified aerosol propellant A at a minimal pressure far less than the aerosol propellant A phase pressure by means of equilibration with carbonation beverage pressure, and when the aerosol propellant A pressure acting inside the aerosol propellant receptacle 20 walls equilibrates with beverage pressure acting outside the aerosol propellant receptacle 20 walls. The aerosol propellant receptacle sealed bottom wall 204 is flexible. A substantially conical valve seat 205 protrudes outwardly in a downward direction from the center of the aerosol propellant receptacle bottom wall 204 to form a valve seat 205. The inside surface of valve seat 205 forms a valve seat recess 207, which is designed to sealingly mate with the sealing cone 301 of a substantially tubular stem valve 30, so that liquified aerosol propellant A contained inside the aerosol propellant receptacle 20 will not boil and escape from within the aerosol propellant receptacle 20 when the force generated by the pressure acting outside walls of the aerosol propellant receptacle 20 is greater than the pressure of the aerosol propellant A acting on the inside walls of the aerosol propellant receptacle 20. Advantageously, the aerosol propellant receptacle 20 valve

seat recess 207 will not form a seal with the sealing cone 301 if the force due to pressure acting on outside of the aerosol propellant receptacle 20 walls is less than the force due to the liquified aerosol propellant A pressure acting on inside walls of the aerosol propellant receptacle 20. Conventional aerosol propellant storage systems simply store aerosol propellant in a phase equilibrium state so that the gas phase pressure is equal to the liquid phase pressure. However aerosol propellant receptacle 20 is designed to store the liquified aerosol propellant A in a phase locked condition, so that the gaseous phase is at a pressure slightly higher than that required to liquify the aerosol propellant A at the temperature of the liquified aerosol propellant R. Advantageously, a higher packing fraction of liquified aerosol propellant A to aerosol propellant receptacle 20 volume can be achieved by this invention. The expected maximum packing fraction is recorded by empirical studies, is about 90%.

The apparatus 10 further comprises a stem valve 30 for mating with and forming a valve seal with aerosol propellant receptacle 20. The stem valve 30 is essentially a tubular valve that mates with aerosol propellant receptacle 20. Stem valve 30 comprises a short cylindrical tube 308 of a length of about ½ inches and diameter 3/8 inch which protrudes from the bottom surface 307 of a sealing cup flange 302 and connects to a conical tube stem valve body 300 of a length of about 3 inches. Sealing cup flange 302 is shaped like a shallow suction cup of a diameter of approximately 1 inch and a depth of about 1/4 inch, for sealing against container domed inside bottom wall 107 of the beverage container 100. The dimensions given are only for the sake of comparative clarity of the present invention, and should not be construed as the only possible dimensions for the parts of the apparatus 10. A short small cylindrical stud 304 protrudes from the inside surface of the sealing cup flange 303 in the opposite direction to the stem valve body 300. The approximate diameter of the stem valve stud 304 is 1/4 inch, but it could be larger or smaller depending on the size of the beverage container 100 the apparatus 10 is designed for. A small stem valve hole 305 passes through the entire length of the stem valve 300. The stem valve hole 305 could be made larger inside the stem valve body 300, for reasons of ease of manufacturing. The approximate

diameter of the stem valve hole 305 is about 0.04 inches. Again all of the dimensions sited are examples of one embodiment of the invention. The stem valve cylindrical stud 304 is designed to tightly push or snap into container bottom wall hole 108 to hold the aerosol propellant receptacle 20 and stem valve 30 aerosol propellant receptacle and valve assembly 50 centrally inside the beverage container 100. The sealing cup flange 302 forms a tight seal against the container domed inside bottom wall 107 of the beverage container 100 when the stem valve stud 304 is tightly pushed into the container bottom wall hole 108.

In yet another mode of assembling the apparatus 10, a first step is affixing the stem valve 30 to the aerosol propellant receptacle 20 by passing the stem valve body 300 through the aerosol propellant receptacle neck protrusion opening 203, so that the stem valve cylindrical body 308 seals against the inside surface 208 of the aerosol propellant receptacle neck cylinder 201, and the bottom surface 307 of the stem valve sealing cup flange 302 sealingly mates to outer surface of the aerosol propellant receptacle open neck flange 202. The stem valve 30 is designed to fit snugly and tightly into the aerosol propellant receptacle neck protrusion opening 203, so that a gas tight plug is formed around the aerosol propellant receptacle open neck flange 202. The stem valve 30 is made long enough so that when the bottom surface 307 of the sealing cup flange 302 mates with the aerosol propellant receptacle open neck flange, the conical stem valve body 301 also sealingly abuts the surface of the aerosol propellant receptacle valve seat recess 207. Thus, when the sealing cone 301 abuts the valve seat recess 207 of valve seat 205, pressurized aerosol propellant gas A cannot escape through the stem valve hole 305, or through the aerosol propellant receptacle neck protrusion opening 203. Other methods of practicing the invention do not require that the sealing cone 301 seal the surface of the aerosol propellant receptacle valve seat recess 207 when the stem valve flange 302 is fully seated on the aerosol propellant receptacle open neck flange 202. It is important that the sealing cone 301 be close to or actually contact the inside surface 207 of the aerosol propellant receptacle valve seat recess 207, so that if the pressure inside the aerosol propellant receptacle 20 is less than the pressure outside the aerosol propellant receptacle 20, the aerosol propellant receptacle bottom wall 204 is deflected inwardly to make contact between the inner surface 207 of the aerosol propellant receptacle valve seat recess 207 and the sealing cone 301 to form a gas tight seal that traps any liquified or gaseous aerosol propellant inside the aerosol

propellant receptacle 20 from escaping to the outside through the stem valve hole 305.

To manufacture the apparatus 10, the aerosol propellant receptacle 20 is first filled with clean water 209. The stem valves 30 are then inserted into the aerosol propellant receptacle 20 through the aerosol propellant receptacle neck protrusion opening 203 to displace some water 209 and form a seal with the aerosol propellant receptacle open neck flange 202 and the inside surface 207 of the aerosol propellant receptacle valve seat recess 207. Thus the water 209 is trapped inside the aerosol propellant receptacle 20 and cannot pass through the stem valve hole 305, or the aerosol propellant receptacle protrusion neck opening 203. The aerosol propellant receptacle and valve assembly 50 is then inserted into the beverage container 100, and the stem valve stud 304 is aligned and pushed through the container bottom wall hole 108. The stem valve stud 304 is made slightly larger than the container bottom wall hole 108, so that as the stem valve stud 304 pushes into the container bottom wall hole 108, the stem valve stud 304 forces the container bottom wall hole 108 rim 112 to deform around the rim 112 into a small conical ring 113 of the container 100 material protruding out of the container 100. This conical ring 113 of material forms a tight swage fitting that holds the stem valve stud 304 firmly in place on the container 100. A snap action may also be used for this attachment. The deforming of the container bottom wall hole 108 into a substantially conical rimed hole 114, causes the container wall material to bight into the softer stem valve stud 304 material and form a hematic seal, and a very tight strangle hold on the valve stud 304. The stem valve 30 is pushed into the container bottom hole 108 until the stem valve sealing cup 302 flange makes a tight cup seal between the stem valve 30 and the container domed inside bottom wall 107. Thus, container bottom wall hole 108 deforms to a substantially conical rimmed hole 114 holding the aerosol propellant receptacle and valve assembly 50 in place inside container 100. The apparatus 10 is then transported to a beverage filling plant, where the apparatus 10 is filled with container contents 110 under carbonation pressure in the annular space formed by the boundary of aerosol propellant receptacle and valve assembly 50 and the inside of container 100. The sealing cup flange 302 has a cup wall 306 that seals against the domed surface of the container domed inside bottom wall 107.

During the beverage filling process, a filler head is sealed against the beverage container sealing rim 103. Nitrogen or carbonation pressure is transmitted from the beverage filler head to the

inside space 109 of the beverage container 100. This pressure is also fully transmitted to the aerosol propellant receptacle 20 outer walls. The pressure within the aerosol propellant receptacle 20 builds up and equilibrates with the pressure of the carbonation gas inside the beverage container 100. The pressure outside the aerosol propellant receptacle 20 causes the aerosol propellant receptacle bottom wall 204 to deform slightly, pushing against the trapped water 209 in the aerosol propellant receptacle 20 until the aerosol propellant receptacle valve seat recess 207 inside surface 207 seals tightly against the sealing cone 301 of the conical stem valve body 301. This stops any water 209 from escaping from the aerosol propellant receptacle 20. Since the aerosol propellant receptacle 20 is now filled with only water 209, and water 209 is essentially incompressible, minimal deformation of the aerosol propellant receptacle 20 walls occurs preventing any damage to the thin aerosol propellant receptacle 20 walls. The pressurization of the container 100 with carbon-dioxide gas is important when carbonated container contents 110 is being filled to ensure that the carbonation of the container contents 110 occurs during the filling process. The container contents 110 itself is usually carbonated when it enters the container 100, where, because of the absorption of pressurized carbon-dioxide gas, it becomes highly carbonated. For a container 100 without the aerosol propellant receptacle 20, the container 100 column strength is obtained by the filler head firmly forming a seal with the empty open container sealing rim 103 and pressurizing the container 100 directly with a blast of carbon-dioxide gas. The column strength of the container 100 is obtained by the internal pressure of the container 100. This allows the filler head to firmly seal the container sealing rim 103 to maintain the pressure of the container contents 110 during the filling process. Thus it is important that the above steps be taken in manufacturing a useful self-cooling beverage container. Absence of water 209 could cause the aerosol propellant receptacle 20 walls to collapse and prevent column strength from building up, thus causing the container 100 to collapse under the filler head forces. Thus, during filling, the aerosol propellant receptacle 20 advantageously transmits the filler head forces directly to the water 209 without subjecting the container 100 walls or the aerosol propellant receptacle 20 walls to deformation stresses.

The method of manufacture of the aerosol propellant receptacle 20 generally involves the broad steps of injection molding preforms 600 from suitable plastic materials; blow molding the aerosol propellant receptacle 20 to a shape of particular form; orienting the aerosol propellant

receptacle 20 for filling with water 209; inserting the stem valve 30 into the aerosol propellant receptacle 20; and insertion the aerosol propellant receptacle and valve assembly 50 into beverage containers 100 so that the stem valve stud 304 is pushed to a tight fit into the container bottom wall hole 108; filling the beverage container 100 with container contents 110; seaming the container lid 104 onto the container sealing rim 103; checking for carbonation column strength of the filled and seamed container 100. The steps further comprise; the broad steps of ejecting the water 209 in the aerosol propellant receptacle 20 by pressure feeding a small dose of higher liquified aerosol propellant D into the aerosol propellant receptacle 20 through the stem valve hole 305; said aerosol propellant D opening the seal made between the inside surface 207 of the valve seat recess 207 and the sealing cone 301; using a high pressure piston charger to charge liquified aerosol propellant D through the stem valve hole 305 into the aerosol propellant receptacle 20; storing the apparatus 10 for later sale or use by a consumer.

It is important to know that the liquified phase of the aerosol propellant A to be used for cooling may be either at a lower or higher pressure than the carbonation pressure P_B of container contents 110. This is so because the force generated by the pressure P_B of container contents 110 acting on the outside walls of aerosol propellant receptacle 20 must always be able to overcome the force generated by the pressure P_R of aerosol propellant A acting on the inside surfaces of the aerosol propellant receptacle 20 walls in order to force the inside surface 207 of the aerosol propellant receptacle valve seat recess 207 to form a seal with the sealing cone 301 and trap aerosol propellant A during storage. Also, as the pressure P_B of container contents 110 inside container 100 builds up, the pressure P_B compresses the aerosol propellant receptacle bottom wall 204 and forces the aerosol propellant receptacle bottom 204 wall to bow inward into aerosol propellant receptacle 20. This forces the valve seat recess 207 to mate with stem valve sealing cone 301. Thus, the net projected surface area of the aerosol propellant receptacle bottom that is exposed to the aerosol propellant A pressure P_R is equal to the area of the aerosol propellant receptacle bottom wall 204 minus the area of the inside surface 207 of the valve seat recess 207. This are is always less than the outer surface area of aerosol propellant receptacle bottom wall 204 that is exposed to the carbonation pressure P_B of container contents 110. This difference in areas is equal to the amount of the surface area trapped between the inside surface 207 of the aerosol propellant receptacle valve

seat recess 207 and the sealing cone 301.Thus by adjusting this area, the aerosol propellant A pressure P_R may be made to always exert a force on the aerosol propellant receptacle bottom wall 204 that is less than force exerted by the pressure P_B of container contents 110 on said aerosol propellant receptacle bottom wall. Thus, advantageously, the inside surface of valve seat recess 207 and sealing cone 301 will forcibly mate by this pressure difference and seal off the stem valve hole 305 from the aerosol propellant A completely so that no aerosol propellant A can escape from the inside of aerosol propellant receptacle 20 to atmosphere. During the storage of the unit, this force difference is used to trap aerosol propellant A in a liquid phase-locked state with little or no gaseous phase in aerosol propellant receptacle 20. This is a very efficient way for storing a liquified gas. As stated earlier, if careful calculations are done, it is possible to have the aerosol propellant A pressure equal or greater than the carbonation pressure by adjusting the amount of trapped surface area between the valve seat recess 207 and the sealing cone 301. This makes it possible to use other suitable aerosol propellant of a wider pressure range relative to the product pressure, P_B. The difference in pressure can be estimated by the following formula:

$$P_R \leq \frac{(P_B - P_S)D^2}{(D^2 - d^2)}$$

where P_R is the maximum pressure of the aerosol propellant A to be used, P_B is the pressure of the carbonated beverage, and P_s is the security difference in pressure to be used for the sealing of the aerosol propellant A during storage, and D is the diameter of the bottom aerosol propellant receptacle wall 204, and d is the diameter of the sealing cone 301. P_s is nominally found to be about 5 psi under normal temperature conditions during summer in the State of Florida, USA. In other ambient conditions, the value of P_s will depend on the variability of the carbonation pressure and the aerosol propellant A pressure with ambient conditions, particularly, temperature.

Thus by adjusting the values of d and D in any given design, the aerosol propellant A pressure P_R could be determined for any given stem valve 30 and aerosol propellant receptacle 20 dimensions d and D and given beverage 110 pressure P_B. This offers a great variability in the possible types of aerosol propellant A that could be used for cooling the beverage 110, and a variety of embodiments could be constructed.

Since by design the carbonation beverage pressure P_B will always form a seal for the aerosol propellant A in the aerosol propellant receptacle 20, the removal of the trapped water 209 in the aerosol propellant receptacle 20 is a little demanding. This is achieved by using a higher pressure liquid dose aerosol propellant D other than the aerosol propellant A to be stored in the aerosol propellant receptacle 20. This small liquid dose of aerosol propellant D must always produce a force that tends to open the valve seal. This can be achieved if the pressure P_D of the liquid dose aerosol propellant D, follows the relation,

$$P_D > \frac{(P_B + P_S)D^2}{(D^2 - d^2)}.$$

For example if the carbonation pressure $P_B = 50$ psi, and if $D = 1.86$, $d = .25$, with a safety pressure lock of $P_s = 5$ psi, the aerosol propellant A pressure must be given by,

$$P_R \leq \frac{(50-5)1.86^2}{(1.86^2 - .25^2)} = 45.83 psi$$

and the liquid dose aerosol propellant D pressure required to evacuate the water 209 from the aerosol propellant receptacle 20 must be greater than

$$P_D > \frac{(50+5)1.86^2}{(1.86^2 - .25^2)} = 56.01 psi$$

With the liquid dose aerosol propellant D pressure higher than the aerosol propellant A pressure, carbonation pressure, the liquid dose aerosol propellant D is able to maintain the stem valve 30 and the aerosol propellant receptacle valve seat recess 207 in a relatively open state until all the water 209 and liquid dose aerosol propellant D has escaped from the aerosol propellant receptacle 20. Some liquid dose aerosol propellant D in a gaseous form will remain in the aerosol propellant receptacle 20 to keep the aerosol propellant receptacle 20 walls from collapsing under carbonation pressure.

Upon complete or almost complete removal of the water 209 from the aerosol propellant receptacle 20, the remaining liquid dose aerosol propellant D will be in gaseous form at pressure P_D and will equilibrate with the beverage pressure P_B. The liquified aerosol propellant A that is to

be stored in the aerosol propellant receptacle 20 is then injected through the stem valve hole 305 into the aerosol propellant receptacle 20 by a pressure assist piston pump in a liquified state into the aerosol propellant receptacle 20. This has the advantage of completely filling the aerosol propellant receptacle 20 with liquified aerosol propellant A without deforming the aerosol propellant receptacle 20 walls. Upon completion of the charging, carbonation pressure P_B immediately overcomes the aerosol propellant A pressure P_R acting on the aerosol propellant receptacle bottom wall 204 and pushes valve seat 205 to reseat the valve seat recess 207 against the sealing cone 301, trapping the liquified aerosol propellant A inside the aerosol propellant receptacle 20. Thus the container 100 is now filled with the beverage 110, and the beverage 110 surrounds the aerosol propellant receptacle 20 which has the cooling aerosol propellant A within it. The completed assembly apparatus 10 is then stored or shipped to a customer for consumption.

The process of activation involves simply opening the container lid opening means 105 for consumption, so that the carbonation beverage pressure P_B falls to atmospheric pressure, and the pressure of the liquified aerosol propellant R, P_R acting on the internal walls of the aerosol propellant receptacle 20 causes the aerosol propellant receptacle bottom wall 204 to expand outwards pushing valve seat 205 away from the sealing cone 301, and breaking the aerosol propellant A seal between valve seat recess 207 and the sealing cone 301. Since when the container 100 is in the upright position the sealing cone 301 is above the liquid level of the aerosol propellant liquid mixture A, only aerosol propellant gas A is released through the bottom of the container 100 through the stem valve hole 305. This also has the advantage of preventing liquified aerosol propellant A from exiting the container 100 and causing freeze burns, since the container 100 contents will spill if the container 100 is tilted from the upright position.

To operate the present invention for use as a self-cooling container, no additional activation means is provided other than the beverage container lid opening means 105. Thus a consumer does not have the opportunity to tamper with the unit unless the consumer intends to open the beverage container 100 for consumption. The opening of the beverage container 100 for consumption simultaneously opens the aerosol propellant receptacle valve 205 and aerosol propellant A mixture is progressively discharged in a gaseous phase from the aerosol propellant receptacle 20 through the stem valve hole 305 as it extracts heat from the beverage 110 and evaporates. A process of

manufacturing the above-described self-cooling container apparatus 10 for retaining container contents 110 is provided, including the steps of orienting the stem valves 30 for insertion into the aerosol propellant receptacles 20; filling the aerosol propellant receptacles 20 with water 209; inserting the stem valves 30 into the aerosol propellant receptacles 20; and inserting the assemblies 50 into beverage containers 100; filling each beverage container 100 with beverage 110; seaming or crimping the container lid 104 onto the container 100; then piston pumping a high pressure liquified aerosol propellant dose D into the aerosol propellant receptacle 20 to exhaust the water 209 from the aerosol propellant receptacle 20; then piston pumping liquified aerosol propellant A into the aerosol propellant receptacle 20 for storage of said aerosol propellant A for later use as a cooling agent.

In yet a second embodiment of the invention, a water soluble salt 211 is used as a aerosol propellant medium A when mixed with water. In this embodiment, the aerosol propellant receptacle 20 has a valve seat hole 218 through the center of the aerosol propellant receptacle valve seat recess 207. This configuration is shown in Figure 21 and Figure 22. This valve seat hole 218 allows fluid communication between the inside of the aerosol propellant receptacle 20 and the container contents 110 which generally contains water as part of its recipe, when the pressure inside the aerosol propellant receptacle 20 is greater than the container contents 110 pressure. When the apparatus is assembled and the valve stem 30 bottom edge 301 mates with valve seat recess 207, no fluid communication exists between the inside of aerosol propellant receptacle 20 and the atmosphere, or the inside of the aerosol propellant receptacle 20 and the container contents 110. In this embodiment, valve seat recess 207 is made to be initially tightly seated on sealing cone 301 to prevent any fluid container contents 110 from entering the aerosol propellant receptacle through the valve seat hole 218. This is achieved by simply pulling a vacuum through valve stem hole 305. Since this causes the inside of the aerosol propellant receptacle to have a negative pressure relative to atmosphere during the container contents filling process, a blast of carbonation pressure further seals the aerosol propellant receptacle valve seat recess 207 to the sealing cone 301 and this seal is maintained throughout and after the filling of the container contents 110 and during storage. The container contents pressure P_B pressure difference with the inside of the aerosol propellant receptacle 20 will seal off the aerosol propellant receptacle valve seat hole 218 so that no container

contents 110 can enter into the aerosol propellant receptacle 20.

During the manufacturing process, the aerosol propellant receptacle 20 is first filled with a water soluble salt 211 such as sodium chlorate which has a heat of solvation of $\Delta H = +21.72$ Kilo joule per mole. Stem valve 30 is assembled with the aerosol propellant receptacle 20 as in the previous embodiment. The general shape and sizes of the aerosol propellant receptacle and valve stem is the same as in the previous embodiment. Thus, when the aerosol propellant receptacle and stem valve assembly 50 is attached to container 100 as in the previous embodiment, and the container contents 110 are sealed inside container 100, the container contents 110 pressure P_B increases and compresses the aerosol propellant receptacle bottom wall 204 inwardly and forces the aerosol propellant receptacle bottom 204 wall to bow inward into aerosol propellant receptacle 20. This forces the valve seat recess 207 to forcibly mate with sealing cone 301 and seal off valve seat hole 218. Since there is no internal aerosol propellant in the aerosol propellant receptacle 20, when container 100 is sealed, the container contents pressure P_B start to slowly permeate through the aerosol propellant receptacle 20 walls to mix with the salt crystals 211 and equilibrate inside of aerosol propellant receptacle 20 with the container contents pressure.

After equilibration, the valve seat will remain closed by design, since the valve stem 30 is made slightly longer and to snugly mate with valve seat recess 207 by a mechanical force. Thus, the inside surface of valve seat recess 207 and sealing cone 301 will stay forcibly mated and seal off the aerosol propellant receptacle valve seat hole 218 so that no container contents 110 can enter into the aerosol propellant receptacle 20 through aerosol propellant receptacle valve seat hole 218. Aerosol propellant receptacle valve seat hole 218 is about ⅛th of an inch in diameter. After storage, and when the container contents are desired for consumption, the consumer simply opens the container lid opening means 105 to consume the container contents 110. The product pressure P_B falls to atmospheric pressure, and the carbonation gas trapped under pressure by permeation inside the aerosol propellant receptacle 20 causes the aerosol propellant receptacle 20 walls to expand irreversibly, and aerosol propellant receptacle valve seat recess 207 is pushed away from the sealing cone 301. This expansion of the aerosol propellant receptacle valve seat 205 breaks the mating lock between the aerosol propellant receptacle valve seat recess 207 and the sealing cone 301. This allows some of the fluid body of container contents 110 to enter into the aerosol propellant

receptacle 20 through aerosol propellant receptacle valve seat hole 218 and permeate the salt crystals 211. The reaction of the water content of the container contents 110 and the salt crystals 211 is endothermic. This results in the cooling of the product 211 by the endothermic reaction of salt crystals and water.

Referring to FIGURES 2 AND 24-29 scented self cooling beverage bottle apparatus 60 is disclosed. In the first of the preferred of several possible embodiments, the apparatus 10 includes a plastic bottle 500 containing contents 110 having a conventional unified bottom wall 502, and a terminating in an upper bottle threaded neck 503. A bottle threaded cap 504 is also provided for sealing off the bottle contents 110 inside the bottle 500. The bottom wall of the bottle 500 is unified with an internally projecting aerosol propellant receptacle 520 so that a contiguous beverage chamber 505 is formed between aerosol propellant receptacle 520 and the inside of the bottle 500, and the inside chamber 510 of the aerosol propellant receptacle 520 forms a receptacle for aerosol propellant mixtures A. bottle 500 is made from a two part contiguous preform 60 that comprises two separate chambers 511 and chamber 512 fused together to form a concentric cylindrical beverage chamber 505 and an aerosol propellant chamber 510. Chamber 511 terminates in an open bottle threaded neck 503. Chamber 512 terminates in a open threaded sealing neck 506 and has a contiguous bottom that form a conical valve seat 526. Chamber 512 is essentially almost contained within chamber 511, except for the threaded sealing neck 506 which protrudes away from the chamber 511. The preform 60 is used to make the separate chambers that will hold the aerosol propellant A and the bottle contents 110.

To manufacture the apparatus, preform 80 is first heated and then blow molded through the bottle threaded neck 503 to expand chamber 511 into a mold that takes the desired shape of the bottle. Then while holding the shape of valve seat 526 through bottle threaded neck 503 with a mold support member that keeps the shape of the valve seat 526, chamber 512 is blown to form an aerosol propellant receptacle 520withsubstantially paraboloid receptacle side walls 507. The walls may take on any particular shape that will conform to the pressure response characteristics of the plastic material used for the prepform 80. The aerosol propellant receptacle 520 is thus substantially within the formed bottle 500 with its open threaded sealing neck 506 facing in a direction opposite

to the bottle threaded neck 503.

The sizes of the bottle 500 and the aerosol propellant receptacle 520 may be varied to any suitable ratio, but a desirable ratio is about

$$\frac{propellant\_chamber\_volume}{Beverage\_chamber\_volume} = \frac{1}{3}.$$

The aerosol propellant receptacle open threaded sealing neck 506 is preferably, but not necessarily, smaller than the bottle 500 threaded neck 503. The inside surface of valve seat 525 forms a valve seat recess 527, which is designed with an o-ring groove 539 to sealingly mate with the stem valve o-ring 531 of a substantially tubular stem valve 70, so that liquified aerosol propellant A contained inside the paraboloid receptacle side walls 507 will not boil and escape from within the aerosol propellant receptacle 520 when the force generated by the pressure acting outside walls of the aerosol propellant receptacle 520 is greater than the pressure of the aerosol propellant A acting on the inside paraboloid receptacle side walls 507 of the aerosol propellant receptacle 520. Advantageously, the aerosol propellant receptacle 520 valve seat recess 527 will not form a seal with the o-ring 531 if the force due to pressure acting on outside of the aerosol propellant receptacle 520 walls is less than the force due to the liquified aerosol propellant A pressure acting on inside walls of the aerosol propellant receptacle 520. Conventional aerosol propellant storage systems simply store aerosol propellant in a phase equilibrium state so that the gas phase pressure is equal to the liquid phase pressure. However aerosol propellant receptacle 520 is designed to store the liquified aerosol propellant A in a phase locked condition, so that the gaseous phase is at a pressure slightly higher than that required to liquify the aerosol propellant mixture A at the temperature of the liquified aerosol propellant A. Advantageously, a higher packing fraction of liquified aerosol propellant A to aerosol propellant receptacle 520 volume can be achieved by this invention. The expected maximum packing fraction is recorded by empirical studies, is about 90%.

The apparatus 60 further comprises a stem valve 70 for mating with and forming a valve seal with aerosol propellant receptacle 520 . The stem valve 70 is essentially a tubular valve that mates with aerosol propellant receptacle 520 . Stem valve 70 comprises a short cylindrical tube 534 of a length of about ½ inches and diameter 3/8 inch which protrudes from the bottom surface 537 of a sealing threaded cap 532 and connects to a conical tube stem valve body 530 of a length of about

3 inches. Sealing threaded cap 532 is shaped like regular cylindrical locking cap to mate and thread snugly into threaded sealing neck 506 . It is also configured in the shape of a cup 538 so that when it threads and seals unto threaded sealing neck 506 it forms a base 540 for bottle 500 to stand on. A short small cylindrical stud 534 protrudes from the inside surface of the threaded sealing neck 506 in the opposite direction to the stem valve body 530. The approximate diameter of the stem valve stud 534 is 1/4 inch, but it could be larger or smaller depending on the size of the beverage bottle 500. A small stem valve hole 535 passes through the entire length of the stem valve 70. The stem valve hole 535 could be made larger inside the stem valve body 530, for reasons of ease of manufacturing. The approximate diameter of the stem valve hole 535 is about 0.04 inches. Again all of the dimensions sited are examples of one embodiment of the invention.

In assembling the apparatus 50, a first step is affixing the stem valve 70 to the aerosol propellant receptacle 520 by passing the stem valve body 530 through the aerosol propellant receptacle neck protrusion opening 523, so that the stem valve cylindrical body 538 seals against the inside surface 528 of the aerosol propellant receptacle neck cylinder 521, and the bottom surface 537 of the stem valve sealing threaded cap sealingly mates to rim of the aerosol propellant receptacle threaded sealing neck 506. The stem valve 70 is designed to fit snugly and tightly into the aerosol propellant receptacle neck protrusion opening 523, so that a gas tight plug is formed around the aerosol propellant receptacle open neck 522. The stem valve 70 is made long enough so that when the bottom surface 537 of the sealing threaded cap 532 mates with the threads of threaded sealing neck 506, the conical stem valve body 538 also sealingly abuts the surface of the aerosol propellant receptacle valve seat 526 Thus, when the o-ring 531 abuts the valve seat 526, pressurized aerosol propellant gas A cannot escape through the stem valve hole 535, or through the aerosol propellant receptacle neck protrusion opening 523. Other methods of practicing the invention do not require that the o-ring 531 seal the surface of the aerosol propellant receptacle valve seat recess 527 when the sealing threaded cap 532 is fully seated on the aerosol propellant receptacle open neck 522. It is important that the o-ring 531 be close to or actually contact the inside of the aerosol propellant receptacle valve seat recess 527, so that if the pressure inside the aerosol propellant receptacle 520 is less than the pressure outside the aerosol propellant receptacle 520, the aerosol propellant receptacle bottom wall 524 is deflected inwardly to make contact between

the inner surface of the aerosol propellant receptacle valve seat recess 527 and the 531 to form a gas tight seal that traps any liquified or gaseous aerosol propellant inside the aerosol propellant receptacle 520 from escaping to the outside through the stem valve hole 535.

The manufacture of the apparatus is the same process as described earlier, where the aerosol propellant receptacle 520 is first filled with clean water 209. The stem valves 60 are then inserted and threaded into the aerosol propellant receptacle 520 through the aerosol propellant receptacle neck protrusion opening 523 to displace some water 209 and form a seal with the aerosol propellant receptacle open neck 522 and the inside surface of the aerosol propellant receptacle valve seat recess 207. Thus the water 209 is trapped inside the aerosol propellant receptacle 520 and cannot pass through the stem valve hole 535, or the aerosol propellant receptacle protrusion neck opening 523. The apparatus 60 is then transported to a beverage filling plant, where it is filled with contents 110 under carbonation pressure in the annular space formed by the boundary of aerosol propellant receptacle 520 inside of bottle 500. The sealing threaded cap 532 has a cup 536 that seals against the bottom surface of the bottle to form a stand.

During the beverage filling process, a filler head is sealed against the bottle threaded neck 503. Nitrogen or carbonation pressure is transmitted from the beverage filler head to the inside space 509 of the beverage bottle 500. This pressure is also fully transmitted to the aerosol propellant receptacle 520 outer walls. The pressure within the aerosol propellant receptacle 520 builds up and equilibrates with the pressure of the carbonation gas inside the beverage bottle 500. The pressure outside the aerosol propellant receptacle 520 causes the aerosol propellant receptacle bottom wall 524 to deform slightly, pushing against the trapped water 209 in the aerosol propellant receptacle 520 until the aerosol propellant receptacle valve seat recess inside surface 527 seals tightly against the o-ring 531 of the conical stem valve body 538. This stops any water 209 from escaping from the aerosol propellant receptacle 520. Since the aerosol propellant receptacle 520 is now filled with only water 209, and water 209 is essentially incompressible, minimal deformation of the aerosol propellant receptacle 520 walls occurs preventing any damage to the thin aerosol propellant receptacle 520 walls. The pressurization of the bottle 500 with carbon-dioxide gas is important when carbonated container contents 110 is being filled to ensure that the carbonation of the bottle contents 110 occurs during the filling process. The contents 110 itself is usually carbonated when it enters

the bottle 500, where, because of the absorption of pressurized carbon-dioxide gas, it becomes highly carbonated. A bottle threaded cap 504 is provided and is used to seal the bottle contents 110 inside the bottle 500. The rest of the process is exactly the same as those needed for charging and filling a metal container as described earlier.

While the above specifications reveal one of many embodiments of the present invention, it must be noted that several different representations of the invention could be constructed by one skilled in the art without limiting the generality of the invention.